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GEOPHYSICS.—*Tidal phenomena in Long Island Sound.*[1] EMBERT A. LELACHEUR, U. S. Coast and Geodetic Survey. (Communicated by W. D. SUTCLIFFE.)

The earliest tide observations on record in Long Island Sound were made in 1835. Tidal currents were first observed in this waterway in 1845. A study of the observational data from 150 tide stations and over 300 current stations in this region has resulted in information concerning the tidal phenomena in this waterway which should prove to be of considerable value to the navigator, the scientist and the engineer.

The tide in Long Island Sound is derived from that of the North Atlantic Ocean and, as inferred from the results of observations mentioned above, consists primarily of a stationary wave. According to the stationary-wave theory of tides, advanced by R. A. Harris, regional oscillatory areas are located in various portions of the oceans as the origin of the dominant tides, these oscillations being set up and maintained by the periodic tidal forces of the sun and moon. Therefore, the tides of any region are caused by the stationary-wave oscillation of that particular region and the tides of areas not capable of sustaining a stationary wave are caused by a progressive wave from an oscillating system of the open ocean.[2]

For a body of water to support a stationary tidal wave its period of oscillation should be nearly the same as that of the tide, or approximately 12 hours. If the period of oscillation for Long Island Sound be

[1] Received April 25, 1931. Presented before the Philosophical Society of Washington, April 11, 1931.

[2] G. T. Rude, The figure of the earth. Bull. Nat. Research Council 78: 5. 1931.

derived from the stationary-wave formula, $T = \frac{4L}{\sqrt{gh}}$, in which L = length of body of water or approximately 82 nautical miles (498,560 feet), g = acceleration of gravity or 32.2 feet per second, and h = average (mean tide level) depth of water or 71 feet, a value of 41,720 seconds, or 11.6 hours, is obtained. This approximates to the period of oscillation of the tide, and the body of water will, therefore, support a stationary wave.

From the formula for a progressive tide wave, $r = \sqrt{gh}$, in which r = rate of tide progression, g = acceleration of gravity or 32.2 feet per second, and h = average (mean tide level) depth of water or 71 feet, a value of 47.8 feet per second is obtained for the rate of progress of the tide wave. As the distance between the two extremities of the waterway is approximately 82 nautical miles, or 498,560 feet, the time that it should take for the tide wave to be propagated from Little Gull Island Light to Throgs Neck should be approximately 10,430 seconds, or 2.9 hours. As determined from the Greenwich lunitidal intervals derived from observations at these tide stations, the actual times of propagation of high and low water, respectively, throughout Long Island Sound are $1\frac{3}{4}$ hours and $2\frac{1}{4}$ hours.

From the above considerations it will be noted that the tide in Long Island Sound is produced by a combination of the stationary and progressive types of tide wave, the former predominating. According to Harris, this progression is not due to a shoaling at the mouth or entrance to the waterway, such as obtains in the Gulf of Maine and Bay of Fundy, but rather to a contraction. In addition to this contraction there are obstacles to the progression of the tide wave such as Fishers, Little Gull, Great Gull, and Plum Islands and numerous rocky shoals and reefs.

There is an earliness in the time of occurrence of high and low water along the north shore of Long Island Sound as compared with such phenomena along the south shore. From the vicinity of Eaton Point, L. I., westward, however, there is practically no difference in time of tide or range of tide along either shore of the sound. Likewise, there is an earliness in the time of occurrence of the tidal current along the north shore of the sound. The acceleration in the time of current, however, is due to the fact that the current generally occurs earlier in shoaler waters than in midchannel and the waters along the Connecticut shore are relatively considerably shoaler than those along the north coast of Long Island, especially in Eastern Long Island Sound.

The tide produced by a stationary wave should exhibit considerable increase in range throughout the waterway. This is true in Long Island Sound, the range increasing from approximately 2½ feet at Little Gull Island Light to about 7¼ feet at the western end of the sound. From Eaton Point, L. I., westward, however, there is practically no difference in the range of tide.

As is true in the Bay of Fundy, Delaware Bay, and other waterways, there is an increase in the range of tide on the right bank, or shore, of Long Island Sound with respect to the propagation of the tide wave. From the latter standpoint the northern shore of Long Island Sound is the right bank, or shore. The theoretical amount (in feet) by which the ranges on the two banks of a tidal stream differ $= \frac{3\,vd\sin\phi}{g}$ approximately, in which v = velocity of water in knots, d = width of waterway in nautical miles, ϕ = latitude, and g = acceleration of gravity. At three cross-sections in Long Island Sound the following differences in range of tide were found: between Rocky Point, L. I., and Lynde Point, Conn., a theoretical difference of 0.3 foot and an actual difference of 0.2 foot; between Roanoke Point, L. I., and Sachem Head, Conn., a theoretical difference of 0.65 foot and an actual difference of 0.6 foot; between Matinicock Point, L. I., and Parsonage Point, N. Y., a theoretical difference of 0.1 foot and an actual difference of 0.1 foot.

The tide in the Connecticut and Housatonic Rivers is primarily of the progressive-wave type. Theoretically, it should require about 4.0 hours for the propagation of the tide wave from Saybrook Breakwater to Hartford, Conn., and 1.0 hour for the same phenomenon in the Housatonic River from Stratford to Shelton. By actual tidal observations, the times of propagation in these rivers between the localities mentioned above are, respectively, approximately 4¾ hours, and 0.95 hour.

The progression of the tidal current is rapid over the 48-mile (nautical) stretch of Eastern Long Island Sound owing to the wide expanse and good depths of the waterway. From Stratford Shoal to Execution Rocks in Western Long Island Sound, a distance of 30 nautical miles, about an hour is required for the progression of the current. In this stretch of the waterway the time of current is retarded considerably by the funnel shape of the waterway which narrows rapidly from a width of about 12 nautical miles, off Bridgeport, Conn., to about 2½ nautical miles off Execution Rocks. At the same time the waterway

rapidly shoals from depths of about 20 fathoms off Stratford Shoal to about 7 fathoms northeast of Execution Rocks. Over the 2½-mile stretch from Execution Rocks to Hart Island Light the progression of the current is exceedingly slow, requiring nearly two hours.

Although the tidal current, or horizontal movement of the water, accompanies the tide, or vertical rise and fall of the water, and is part of the same phenomenon, the results from observations show that there is considerable difference in time of occurrence of strength of flood current and high water at most localities in this waterway. In fact, at the entrances to the bays and harbors along the northern and southern shores of the sound the maximum flood current occurs about the time of local mean-tide level, or approximately three hours before local high water. For example, at the entrances to Huntington Bay, Oyster Bay, Hempstead Bay and Coscob Harbor, strength of flood current occurs earlier than local high water by 2.3 hours, 2.8 hours, 2.9 hours, and 3.1 hours, respectively.

Owing to the presence of a stationary tide wave in Long Island Sound we should expect a large range of tide and a small current velocity at the head of the waterway or western end of the sound and a small range of tide and considerable current velocities in The Race and Plum Gut at the eastern entrance to the sound. Such conditions actually obtain, a range of tide of 7¼ feet and current strength of about ¾ knot occurring off Execution Rocks while in Plum Gut and The Race current velocities of 3½ to 4 knots accompany a tide range of about 2½ feet.

The average (mean-tide level) depth of Long Island Sound is approximately 12 fathoms and this depth would be sufficient to support a stationary tide wave of about 365 nautical miles in length. Measured from the western end of Long Island Sound a north-and-south line one-fourth of this wave length from the head of the sound would lie about 10 miles east of Little Gull Island Light, or immediately east of Montauk Point, Long Island. Such a condition accounts primarily for the small tidal ranges and increased current velocities in The Race, Plum Gut, and the southern entrance to Block Island Sound off Montauk Point.

GEOLOGY.—*The heat of solution of some potash minerals.*[1] L. T. RICHARDSON and R. C. WELLS, U. S. Geological Survey.

The purpose of this paper is twofold—to consider whether measurements of the heat of solution may afford a rapid method of detecting potash minerals or estimating their percentage in gangue material, and to discuss whether the heat of solution may affect the geothermal gradient of such a region as the area of potash deposits in Texas and New Mexico.

Some years ago while visiting the plant of the American Trona Corporation, now the American Potash and Chemical Corporation, at Searles Lake, California, one of the writers was informed that the heat of solution was used in the plant as a control method for certain KCl-NaCl mixtures. Except for single salts few figures are given in the literature for the heat of solution of potash minerals. It accordingly seemed worth while to obtain some figures for these minerals. For this purpose measurements were first made with a few salts over a range of concentrations to find the most favorable conditions for a rapid method.

A 5-gram portion of a ground sample of each salt was placed in a large test tube, surrounded by an air jacket, and its temperature was observed with a thermometer. A portion of water was brought to the same temperature, then poured on the sample, and the mixture stirred with the thermometer. The heat effect usually attained its maximum in ½ to 1½ minutes. Correction was made if necessary for the drift of the temperature caused by exchange of heat with the environment during this interval. Table 1 shows the results. In those experiments in which there was not enough water to dissolve all the salt, the heat of solution was calculated for the gram molecule from the known solubility of the salt.

It is seen from Table 1 that the temperature change is largely independent of the quantity of water as long as the salt is in excess. But on account of ease of stirring and uniformity of conditions, 25 grams of water, 5 grams of salt, and a short piece of a 35 mm. test tube were selected as the best combination for further work.

When mixed salts are used, the heat effect obtained with a little water and a low percentage of KCl resembles that obtained with more water and a high percentage of KCl, and it is greater than that obtained with the same mixture of salts dissolved in more water. Both NaCl and KCl lower the temperature on dissolving in water.

[1] Received April 11, 1931. Published by permission of the Director of the U. S. Geological Survey.

The results obtained with the minerals and some mixtures of minerals and salts are given in Table 2. Owing to incomplete solution in

TABLE 1. HEAT OF SOLUTION OF SOME SALTS (5-GRAM SAMPLE)

Salt	Diameter of tube (mm)	H_2O (grams)	Time (min.)	Final temperature (°C.)	Change in temperature (°C.)	Mols H_2O per mol of dissolved salt	Molecular heat of solution (cal.)
NaCl	23	5	½	22.7	−1.8	10	−500
"	"	10	"	21.2	−1.8	"	−510
"	35	25	1	23.3	−1.7	16	−590
KCl	13	5	½[a]	—	−9.1	—	—
"	16	"	"[a]	—	−12.1	—	—
"	20	"	1[a]	—	−10.6	—	—
"	23	"	½	10.2	−11.4	12	−3820
"	"	"	1	12.8	−10.5	"	−3520
"	"	"	1½	13.0	−10.4	"	−3490
"	50 ml.[b]	"	"	—	−9.7	—	—
"	23	10	1	10.8	−12.9	12	−3740
"	"	"	1	11.1	−12.6	"	−3650
"	"	15	1½	10.4	−11.7	"	−3220
"	"	20	2	12.4	−10.3	16	−3800
"	"	"	2½	13.9	−10.4	"	−3830
"	"	25	½	14.4	−9.6	21	−3940
"	"	"	"	14.0	−8.6	"	−3530
"	35	"	"	16.0	−9.0	"	−3800
"	"	"	1½	16.2	−8.6	"	−3630
K_2SO_4	23	5	½	22.1	−2.7	87	−6320
"	35	25	2	21.5	−3.5	"	−6600
$MgCl_2 \cdot 6H_2O$	23	5	1	26.3	+3.5	16	+914
2.5 NaCl, 2.5 KCl	"	"	½	16.3	−5.7	—	—
" " " "	"	10	1	14.0	−7.5	—	—
" " " "	"	"	1½	14.5	−7.0	—	—
" " " "	35	25	1	20.8	−4.9	18	−1900
1.0 " 4.0 "	"	"	½	16.2	−7.5	20	−3070
2.0 " 3.0 "	"	"	1½	19.1	−5.9	19	−2330
3.0 " 2.0 "	"	"	½	19.7	−3.5	18	−1320
4.0 " 1.0 "	"	"	"	22.6	−2.7	17	−950
4.5 " 0.5 "	"	"	"	21.1	−2.1	"	−720
4.0 " 1.0 "	23	10	1½	18.5	−4.5	"	—

[a] Stirring difficult.
[b] Beaker.

some cases, as well as to lack of information in regard to the specific heat of the solutions, the figures for the molecular heat of solution must

be considered as somewhat preliminary, but they indicate the direction of the heat effect. The molecular heat of the salt-anhydrite mixtures refers to the soluble salt only.

From Table 2 it appears that polyhalite ($2CaSO_4 \cdot MgSO_4 \cdot K_2SO_4 \cdot 2H_2O$), langbeinite ($2MgSO_4 \cdot K_2SO_4$) and kainite ($MgSO_4 \cdot KCl \cdot 3H_2O$) evolve heat when mixed with water. Polyhalite is rather slowly decomposed, but the heat effect follows that of $MgSO_4$ rather than that of K_2SO_4. With carnallite ($KCl \cdot MgCl_2 \cdot 6H_2O$) the fall of temperature caused by the KCl outweighs the rise due to $MgCl_2 \cdot 6H_2O$, and a net cooling effect results. Although anhydrite alone shows no appreciable heat effect under these conditions a mixture of anhydrite

TABLE 2.—HEAT OF SOLUTION OF SOME POTASH MINERALS (5-GRAM SAMPLE)

Mineral	*Diameter of tube (mm.)*	*H_2O (grams)*	*Time (min.)*	*Final temperature (°C.)*	*Change in temperature (°C.)*	*Mols H_2O per mol of dissolved salt*	*Molecular heat of solution (cal.)*
Polyhalite	23	5	½	26.0	+0.9	35	(+834)
Langbeinite	35	"	"	22.9	+2.4	24	+5,600
"	"	25	"	24.0	+1.2	39	+2,900
Kainite	"	"	"	25.0	+1.0	35	+1,520
Carnallite	23	5	"	16.8	−5.9	8	−2,900
"	35	25	"	21.5	−2.0	39	−3,300
Anhydrite	"	"	"	—	−0.0	—	—
2.5 " 2.5 KCl	"	10	1½	13.8	−9.1	17	−3,600
" " " "	"	25	½	20.7	−4.8	42	−4,200
4.0 " 1.0 "	23	10	1	18.8	−4.1	41	−5,200
" " " "	35	25	½	22.7	−2.2	100	−4,900
2.0 " 0.5 " 2.5 NaCl	"	"	"	21.6	−2.0	27	−1,200

and sylvite (KCl) seems to give a proportionately greater cooling effect than sylvite alone. This may be caused by the low specific heat of anhydrite (0.1753) or it may indicate a metathetical reaction.

In view of the opposite directions of some of the heat effects, as well as variations caused by the proportions and kinds of minerals, it is obvious that the heat effect with an unknown mixture of potash minerals will not bear any simple relation to the K_2O content. Some samples might have a positive heat of solution, some a negative, and some none. On the other hand, in specific mixtures the heat of solution might give definite information—for example, in a mixture consisting only of sylvite and halite.

In Table 3 some figures are given for two sections of core, mainly

sylvite in halite, from Blanchard well No. 3 of the United States Potash Co., in Sec. 10, T.21 S., R.29 E., Eddy County, New Mexico. Ground samples of 3-inch portions were prepared, and the tests were made with 25 grams of water as given for langbeinite in Table 2. One section shows a fairly uniform change in the heat effect from top to bottom; the other shows extreme irregularity. Without more detailed information about each sample, calculations of the K_2O content are practically impossible.

The whole section from 791′ to 795′ averaged 3.58 per cent K_2O, with increasing proportions of clay toward the bottom. For the

TABLE 3.—FALL IN TEMPERATURE RESULTING FROM SOLUTION OF SAMPLES OBTAINED FROM SUCCESSIVE 3-INCH PORTIONS OF TWO SECTIONS OF CORE FROM BLANCHARD WELL NO. 3

Depth	*Fall in temperature (°C.)*	*Depth*	*Fall in temperature (°C.)*
791′0″—791′3″	3.7	794′9″—795′0″	1.1
791′3″—791′6″	2.9		
791′6″—791′9″	2.0	834′6″—834′9″	1.6
791′9″—792′0″	1.6	834′9″—835′0″	1.9
792′0″—792′3″	2.0	835′0″—835′3″	2.3
792′3″—792′6″	1.2	835′3″—835′6″	2.1
792′6″—792′9″	1.8	835′6″—835′9″	1.7
792′9″—793′0″	1.4	835′9″—836′0″	2.5
793′0″—793′3″	1.7	836′0″—836′3″	2.0
793′3″—793′6″	1.6	836′3″—836′6″	2.4
793′6″—793′9″	1.1	836′6″—836′9″	1.6
793′9″—794′0″	1.3	836′9″—837′0″	2.3
794′0″—794′3″	1.2	837′0″—837′3″	2.7
794′3″—794′6″	1.1	837′3″—837′6″	1.9
794′6″—794′9″	1.1	837′6″—837′9″	2.0

sample at 794′6″ the insoluble matter was 16.03 per cent; the H_2O at 110°, 2.62 per cent. For the sample at 794′9″ the insoluble matter was 9.26 per cent; the H_2O at 110°, 1.73 per cent.

The section from 834′6″ to 837′9″ averaged 9.55 per cent K_2O. As each tenth of a degree change in temperature corresponds to nearly 3 per cent of KCl the variation in the material is very evident, but calculation of the total potash content of the section by addition of the 13 separate results, taking 1.6° fall as representing zero per cent of KCl gives far too little total KCl, so that some factor has evidently not been given due consideration, though what this factor is has not yet been determined.

The field of usefulness of the calorimetric method of analysis of potash minerals is therefore limited to certain special combinations,

and even these will require careful standardization to give quantitative results.

The second question of interest is the geologic application of the heat of solution. Lang[2] has discussed the low geothermal gradients in the area of western Texas and southeastern New Mexico known to be underlain by salt and anhydrite. Although he concludes that the thermal conductivities of the rocks are too poorly known to warrant any definite discussion of the problem, it may be of interest to consider further some of the factors that have been mentioned as responsible for the gradients. Radioactivity of the potassium minerals cannot be a major factor, or at least the heat effect thus produced is in the wrong direction Are water-soluble salts dissolving in ground water or deep solutions at a rate that would cause sufficient cooling to explain the low gradients? In the absence of any simple direct answer to this question it is proposed to make certain assumptions that appear to be too liberal and show that even so the corresponding effects would be insufficient to explain the gradients observed.

For example, let us assume that soluble material is being dissolved at a depth at the same rate at which it is carried off in the surface run-off. This would mean that there would have to be some channel ways or permeable strata for the accession of fresh water and the escape of mineralized water, as simple calculation shows that mere diffusion of the salts from a depth of around 2000 feet would be insufficient to supply the soluble material in the run-off, even if there were enough pore space to insure a continuous aqueous medium.[3]

The quantity of dissolved matter removed annually by the Pecos, Brazos, and Colorado rivers,[4] which drain a part of the area underlain by salt, is of the following order:

Pecos River near Comstock, Texas	2,400,000 tons
Brazos River at Waco, Texas	2,070,000 tons
Colorado River at Austin, Texas	580,000 tons
	5,050,000 tons

Unfortunately the proportion of potash in all of this material is

[2] W. B. Lang. *Note on temperature gradients in the Permian basin.* This JOURNAL 20: 121. 1930.

[3] Such solution as might occur owing to the lowering of the water-table in the earth on account of erosion at the surface or emergence of the area as a whole from sea level would not yield a significant heat effect.

[4] Computed from data given in U. S. Geol. Survey water-supply papers.

not known, so that it is necessary to pursue the inquiry in terms of sodium chloride and calcium sulphate, which are the principal constituents. The substitution of sodium chloride for potassium chloride does not alter the essential conclusions, in spite of the fact that the solution of potassium chloride gives several times the cooling effect of that of the same weight of sodium chloride. It is estimated from analyses of the water that the total annual runoff includes at least 1,300,000 tons of calcium sulphate and 2,800,000 tons of sodium chloride. Assuming that the calcium sulphate comes from the hydration and solution of anhydrite, rather than from gypsum, we have as corresponding heat effects with a large excess of water the evolution of 38×10^{12} calories for the solution of the anhydrite and an absorption of 100×10^{12} calories for the solution of the sodium chloride, leaving a net absorption of about 62×10^{12} calories. Here again, then, we encounter heat effects that are in opposite directions. Such compensating effects make it more difficult but still not impossible to reach definite conclusions.

As the area involved covers about 90,000 square miles, the net heat effect last mentioned reduces to an average of 0.027 calories per square centimeter, or, if concentrated in a single layer 1 cm. in thickness to 0.027 calorie per cubic centimeter. But under a geothermal gradient of 0.000117° C. per cm.,[5] and with rock having the conductivity of anhydrite (0.0123), there would be annually a flow of 45 calories of heat per square centimeter normally escaping from the earth. It is obvious that the heat effect calculated for the solution of anhydrite and sodium chloride would be negligible as explaining the present geothermal gradients. Even if the assumed area of action were contracted to 1,000 square miles the heat of solution would be scarcely significant, amounting to less than 3 calories a year. Expressed differently, to produce the present gradients sodium chloride would have to be dissolved at depth at the rate of a layer nearly a centimeter thick each year, a rate that is incompatible with the known geologic age of the deposits.

In other words, the figures indicate that the quantity of heat normally flowing through the rocks of the earth's crust is large in comparison with the heat of any chemical changes that are likely to take place under nearly static conditions due to such transformations as hydration, solution, carbonation, silicification, and replacement.

[5] Equivalent to 1°F. in 159 feet. This gradient is based on the average for eight wells in the area under discussion, reported in *Earth temperatures in oil fields*, American Petroleum Institute Bull. 205; computed by C. E. Van Orstrand, of the U. S. Geological Survey.

MAMMALOGY.—*Two new desert foxes.*[1] E. A. GOLDMAN, Biological Survey, U. S. Department of Agriculture.

The accession of specimens in recent years has materially extended the known range of the desert foxes of the *Vulpes macrotis* group. Forms of this section of the genus occur in suitable areas from the Pacific coast east to the basin of Great Salt Lake, Utah, and the Rio Grande Valley in New Mexico and western Texas, and from the Snake River Valley, Idaho, south to southern Lower California, Sonora, and Chihuahua. Two hitherto unrecognized geographic races are described below.

Vulpes macrotis arizonensis, subsp. nov.

Arizona Long-eared Desert Fox

Type.—From two miles south of Tule Tanks (near Mexican Boundary), Yuma County, Arizona. No. 202959, ♂ adult, U. S. National Museum (Biological Survey collection), collected by E. A. Goldman, December 9, 1913. Original number 22357.

Distribution.—Desert region of southwestern Arizona and adjoining parts of Sonora.

General characters.—A small, light buffy subspecies with short pelage lacking much of the silver white usual in the group. Skull slender and delicate. Closely allied to *Vulpes macrotis arsipus*, but usually smaller, the winter pelage shorter, brush smaller, and dorsum less heavily overlaid with silvery white; skull differing in detail. Similar in general to *V. m. neomexicana*, but decidedly smaller and dentition much lighter.

Color.—Type: Upper parts in general buffy brownish, purest on head, less pronounced along median line, paling to light ochraceous buff along flanks, the dorsum rather thinly overlaid with silvery white producing a somewhat grizzled effect; dorsal pelage with narrow subterminal white bands, and black tips so short and inconspicuous the general tone is scarcely affected; middle of face buffy grayish; chin, throat, median line of abdomen, inguinal region and inner sides of limbs nearly pure white; sides of neck, a narrow band across lower part of neck, anal region, sides of abdomen, and areas conspicuously invading upper parts behind shoulders light ochraceous buff; outer sides of forearms and hind legs, and external base of ears rich ochraceous tawny; feet whitish, the hind feet becoming light ochraceous buff on soles; sides of muzzle and lips, except anteriorly, dusky; outer sides of ears buffy-brownish, inner sides thinly clothed with white hairs; tail grayish, becoming light ochraceous buffy on basal half below, the tip black all around.

Skull.—Closely resembling skulls of small individuals of *arsipus*, but sides of brain-case converging in more nearly straight lines (tending more distinctly to bulge outward anteriorly in *arsipus*); interpterygoid fossa narrower; anterior processes of frontals broader, more prolonged, meeting ascending branches of premaxillae (frontal processes separated from ascending branches of premaxillae by a distinct gap along maxillo-nasal suture in *arsipus*); auditory bullae small and dentition light much as in *arsipus*. Similar

[1] Received April 7, 1931.

to that of *neomexicana*, but decidedly smaller, slenderer and more delicate; dentition relatively lighter.

Measurements.—Type: Total length, 784 mm.; tail vertebrae, 315; hind foot (c.u.), 120. An adult male from Vicksburg, Arizona: 765; 300; 116. An adult female topotype: 735; 270; 115. An adult female from Yuma, Arizona: 712; 270; 117.5. *Skull* (type): Greatest length, 111.5; condylobasal length, 108.4; width of braincase, 42.5; zygomatic width, 56.4; least width of rostrum, 15.4; interorbital width, 21; maxillary toothrow (front of canine to back of last molar), 52.5; upper carnassial, crown length of outer side, 10, crown width anteriorly, 4.3.

Remarks.—V. m. arizonensis is closely allied to *V. m. arsipus* from whose range it appears to be separated by the barrier of the Colorado River. It appears to intergrade with *V. m. neomexicana* in southeastern Arizona. The reduction of the white over the dorsum in the winter pelage seems to be a differential external character worthy of note.

Specimens examined.—Total number, 6, from Arizona as follows: Tacna, 1; Tule Tanks (type locality), 2; Yuma, 2; Vicksburg, 1.

Vulpes macrotis nevadensis subsp. nov.

Nevada Long-eared Desert Fox

Type.—From Willow Creek Ranch, near Jungo, Humboldt County, Nevada. No. 213103, ♂ adult, U. S. National Museum (Biological Survey collection), collected by Mike Gill, December 14, 1915. X catalogue number 13255.

Distribution.—Desert regions from the Humboldt and Snake River valleys of northern Nevada and southwestern Idaho east to the basin of Great Salt Lake, Utah.

General characters.—A subspecies of medium size with long, full, and comparatively dark pelage. Skull with large, fully inflated braincase. Closely allied to *V. m. arsipus*, but less silvery white, the black tips of hairs more in evidence over dorsum, and cranial characters distinctive. Similar to *V. m. neomexicana*, but somewhat darker and skull different.

Color.—Type: Upper parts in general a coarsely grizzled mixture, the dorsal pelage light brown below, the individual hairs with rather broad subterminal white bands and only moderately conspicuous black tips, becoming light ochraceous buff along flanks; middle of face grayish; chin, throat, median line of abdomen, inguinal region and inner sides of limbs nearly pure white; sides of neck, a narrow band across lower part of neck, anal region and sides of abdomen light ochraceous buff; light areas behind shoulders ochraceous buffy, but rather inconspicuous; outer sides of forearms and hind legs and external base of ears rich ochraceous tawny; feet whitish, the hind feet becoming ochraceous buffy on soles; sides of muzzle and lips, except anteriorly, dusky; outer sides of ears buffy brownish, inner sides thinly clothed with white hairs; tail grayish, heavily overlaid with dusky along median line near base above, washed with light ochraceous buff below, a black tip doubtless present in life, broken off.

Skull.—Similar to that of *arsipus*, but broader, more robust; braincase larger, more fully inflated; nasals usually broader, more abruptly tapering posteriorly; dentition similar; auditory bullae small as in *arsipus*. Compared with that of *neomexicana* the skull is somewhat smaller, but relatively broader; braincase broader, more fully inflated; auditory bullae smaller; dentition similar.

Measurements (no body measurements available).—*Skull* (type): Greatest length, 113.7; condylobasal length, 110; width of braincase, 45.6; zygomatic width, 62.8; least width of rostrum, 17; interorbital width, 22.5; maxillary toothrow (front of canine to back of last molar), 52.8; upper carnassial, crown length of outer side, 9.7, crown width anteriorly, 4.6.

Remarks.—The range of *V. m. nevadensis* marks the northern limit of the *V. macrotis* group. This subspecies is most closely allied to *V. m. arsipus* but is somewhat darker, less silvery whitish in color of upper parts and the skull is distinguished by the larger, more fully inflated braincase.

Specimens examined.—Total number, 14, as follows:

Idaho: Grandview (20 miles south), 1 (skull only).

Nevada: Adelaide (near Golconda), 3 (skins only); Carson Sink (10 miles east of Fallon), 1 (skull only); Fallon (between Old River and Soda Lake), 1 (skin only); Jungo (type locality), 5 (4 skins only); Sodaville, 1 (skin only); Sulphur Cow Creek, Humboldt County, 1 (skin only).

Utah: Low, 2.

MAMMALOGY.—*Bats from the Bahamas.*[1] H. HAROLD SHAMEL, U. S. National Museum. (Communicated by JOHN B. REESIDE, JR.)

An interesting collection of bats was made during the summer of 1930 in the Bahama Islands by Dr. Paul Bartsch, Curator of the Division of Mollusks in the U. S. National Museum. These specimens, 98 in number, are from islands hitherto unrepresented by any mammals in the national collection.

ARTIBEUS JAMAICENSIS PARVIPES (Rehn)

1902. *Artibeus parvipes* Rehn, Proc. Acad. Nat. Sci. Philadelphia, vol. 54, p. 639. December 8, 1902.

Twenty-four specimens were taken on Great Inagua Island and four specimens at Abrahams Hill, Mariguana Island. This bat has hitherto been known only from the island of Cuba. Its capture in the Bahama Islands bears out, in part, a belief of Andersen,[2] the recent reviser of this genus, who said he believed that it would be found throughout the Bahamas and as far north as southern Florida.

MACROTUS WATERHOUSII COMPRESSUS (Rehn)

1904. *Macrotus waterhousii compressus* Rehn, Proc. Acad. Nat. Sci. Philadelphia, vol. 56, p. 434. June 30, 1904.

Three specimens collected at Salt Point, Jamaica Bay, Acklin Island. The specimens are perfectly typical of, and match in every detail those from the Island of New Providence, the type locality, and from Nassau Island, the only two known localities for this bat.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received April 23, 1931.

[2] K. ANDERSEN. *A monograph of the Cheiroptera genera* Uroderma, Enchisthenes, *and* Artibeus. Proc. Zool. Soc. London, p. 262, 1908.

Macrotus waterhousii heberfolium subsp. nov.

Type.—Adult male in alcohol, No. 255651, U. S. National Museum, collected by Dr. Paul Bartsch at Kingston, Providencialis Island, July 23, 1930.

Diagnosis.—Larger than true *M. waterhousii*, with darker, distinctly tricolor fur.

Color.—The fur and membranes are dark; fur smoky-gray at base; this area followed by a narrower band of whitish gray; the tips a rich coppery brown, but rather sparse; the gray shows through to such an extent that it is nearly the predominant color.

Character.—One outstanding external character is the broad, bluntly rounded nose leaf. In all other specimens of *Macrotus* examined the nose leaf is rather slender and more acutely pointed.

Skull.—The skull is like that of the typical form, except that there is no ridge on the occiput. This ridge is well developed in true *M. waterhousii* as a downward continuation of the occipital crest. The zygomatic breadth, interorbital breadth, greatest length of mandible, and breadth of braincase are slightly greater than these same measurements in skulls from Hispaniola.

Measurements.—(Measurements in parentheses are the extremes of 5 specimens of *Macrotus waterhousii waterhousii* from Hispaniola.) *Type:* Head and body, 68.0; tail, 33.8 (24.2–32.5); tibia 24.0 (21.0–23.0); foot, 14.2 (11.0–12.6); forearm, 57.4 (54.0–55.2); thumb, 8.6; third metacarpal, 44.8 (42.0–43.3); fifth metacarpal, 47.2 (42.6–45.6); ear from meatus, 29.6 (26.2–28.6); ear from crown, 24.6 (21.2–23.2); width of ear, 18.5 (16.2–17.5); total length of skull, 26.6; zygomatic breadth at base of zygoma, 13.2 (11.8–12.4); interorbital constriction, 4.6 (4.2–4.5); breadth of braincase, 10.0 (9.2–9.6); greatest length of mandible, 18.4 (16.8–18.0); maxillary toothrow, 9.8.

Only one specimen of this bat was secured in a cave on the island. I am informed by Doctor Bartsch that it was the only occupant of this cave.

Its nearest relative is *Macrotus waterhousii waterhousii* from Hispaniola, as one would expect from the geographical position of its habitat. There are so many differences in its external measurements, and the color is so unlike that in any known *Macrotus* from the West Indies that there can be little doubt that it represents a new form. The fur on the back in other West Indian forms is bicolor, whitish basally with much paler brownish tips.

Erophylla planifrons mariguanensis subsp. nov.

Type.—Adult male in alcohol, No. 255593, U. S. National Museum, collected by Dr. Paul Bartsch at Abrahams Hill on Mariguana Island, July 20, 1930.

Diagnosis.—A larger, darker form with smaller teeth than true *Erophylla planifrons.*

Color.—Fur at base gray, individual hairs tipped with auburn (Ridgway, 1912). Ventral side drab-buff. The hairs at the base in *E. planifrons planifrons* are whitish when compared with the gray of specimens from Mariguana Island, and the tips of the hairs are much lighter.

Skull.—The skull is like that of typical *Erophylla planifrons* except for the smaller teeth and average greater length.

After comparing eight skulls of this bat with the same number of true *E. planifrons* I find the following: maxillary toothrow, 8.2–8.8 as against 7.6–8.2; total length of skull, 24.8–26.4 as against 24.2–25.5; condylobasal length, 22.2–23.2 as against 20.8–22.2.

Measurements.—Type: Head and body, 65.8; tail, 13.4; tibia 22.4; foot, 15.0; forearm, 49.4; thumb, 12.0; third metacarpal, 41.5; fifth metacarpal, 41.6; ear from meatus, 20.6; ear from crown, 16.0; width of ear, 12.2; total length of skull, 26.4; condylobasal length, 23.2; zygomatic breadth, 10.6; interorbital breadth, 4.8; breadth of braincase, 10.2; occipital depth, 8.8; greatest length of mandible, 17.4; maxillary toothrow, 8.8; breadth of rostrum at m^2, 7.0; mandibular toothrow, 9.2.

There were no dry skins, but eight specimens which had been in alcohol since July were dried, and compared with 18 skins of *Erophylla planifrons planifrons* from Nassau and New Providence. This comparison shows that the southern form is considerably darker. There were three skins from Nassau and New Providence which approached those from Mariguana and East Caicos in color, but such resemblance may be expected in forms so closely related. However, the two forms were distinct when laid out in nearby series.

From among eight skulls of each of the two races all except three could be separated by the differences in the size of the teeth.

Fifty specimens were examined from Abrahams Hill, Mariguana Island, and 16 specimens from Stubbs Guano Cave, East Caicos.

SCIENTIFIC NOTES AND NEWS

Because of the generally adverse economic conditions throughout the world, the organization committee of the Sixteenth International Geological Congress has decided to postpone until June, 1933, the meeting of the Congress which had been scheduled for Washington in June, 1932.

The Smithsonian Institution has received from the estate of the late JAMES ARTHUR somewhat more than $50,000 to establish a yearly lecture about the sun. The remainder of the income from this fund is to be devoted to researches relating to the sun.

At the annual meeting of the National Academy of Sciences, which met in Washington on April 27, 28, and 29, the following officers were elected:

President, WILLIAM WALLACE CAMPBELL, director emeritus of Lick Observatory.
Vice-President, DAVID WHITE, U. S. Geological Survey.
Home Secretary, FRED E. WRIGHT, Geophysical Laboratory of the Carnegie Institution of Washington.
Members of the Council, W. B. CANNON, Harvard Medical School, and ROGER ADAMS, University of Illinois.

E. O. ULRICH, geologist of the U. S. Geological Survey, has been awarded the Mary Clark Thompson medal "for the most important services to geology and paleontology." The presentation was made by RUDOLPH RUEDEMANN, state geologist of New York, at the annual dinner of the National Academy of Sciences.

ADOLF KNOPF, professor of geology at Yale University, a member of the ACADEMY and a geologist of the Geological Survey, has been elected to membership in the National Academy of Sciences.

Prof. W. H. TWENHOFEL of the University of Wisconsin has been elected chairman of the Division of Geology and Geography of the National Research Council, succeeding ARTHUR KEITH. He will take office July 1.

The Alaskan Branch of the U. S. Geological Survey is to make an intensive study of the mineral resources of the Alaskan Railroad this season, and will employ temporarily several additional geologists. R. W. RICHARDS of the Fuel Section and C. P. ROSS, F. G. WELLS, J. C. REED, and C. F. PARK of the Section of Metalliferous Deposits of the Geologic Branch have been transferred to the Alaskan Branch for this purpose. J. M. HILL and G. A. WARING, former members of the geologic staff of the Survey, and J. C. RAY and RALPH TUCK have been appointed geologists for the Alaskan Railroad work. PERRY A. DAVISON, also, has been appointed junior geologist on the Alaskan Branch.

SIR JAMES H. JEANS, former secretary of the Royal Society of London and research associate of the Carnegie Institution of Washington, spoke on the subject *Out in the depths of space* at the National Museum on May 18, under the auspices of the Carnegie Institution of Washington.

PAUL H. OEHSER, for the past six years a member of the editorial staff of the Bureau of Biological Survey, succeeds Dr. MARCUS BENJAMIN, retired, as editor of the National Museum.

ROLLIN E. STEVENS has been appointed assistant chemist in the Geological Survey and has taken up the study of the chemistry relating to the origin of certain ore deposits.